AQUATIC MACROINVERTEBRATES AND WATER QUALITY CHARACTERISTICS IN FIVE WETLAND TYPES: PRELIMINARY RESULTS ON BIOMONITORING

Juliann Battle, Stephen W. Golladay, and Brian Clayton

AUTHORS: J.W. Jones Ecological Research Center, Route 2, Box 2324, Newton, GA 31770.
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Abstract. In southwest Georgia, wetlands can be classified based on source of inundation and vegetation. Depressional wetlands are inundated predominantly through rainfall and are identified as grass-sedge **marshes**, cypress **savannas**, and cypress-gum **swamps**. Riparian **sloughs**, composed of cypress and gum, occur along river corridors and are flooded when rivers are at high flow. During 1998-2000, we sampled water and aquatic invertebrates in replicates of these 4 wetland types, as well as, agriculturally **disturbed** marshes. Multivariate analysis indicated that sloughs had the highest levels of inorganic carbon and pH, which we attributed to river water inputs. Compared to the other depressional wetlands, disturbed marshes had approximately five-fold higher PO_4-P concentrations. Disturbed wetlands most likely derive nutrient inputs from soil and fertilizer runoff from nearby agricultural fields. Macroinvertebrate communities were similar between sloughs and swamp sites given that both wetland types had rather low diversity and numbers. Marsh and disturbed wetlands were also comparable and characterized by Belostomatidae and *Tropisternus*. Vegetation appears to be the primary factor that determines macroinvertebrate assemblages. Preliminary results indicated that of the proposed 31 metrics four were potentially capable of distinguishing disturbed and reference marshes with the best metrics being % isopods and % scavengers. Ongoing research will confirm whether these metrics can be used to monitor impacted/restored wetlands.

INTRODUCTION

From the mid-1950's to the mid-1970's, 85% of the wetland loss in the United States has been in the southeast (Hefner and Brown 1985). Wetlands are easily drained and filled, and as a result they are rapidly being degraded and removed from the landscape of Georgia. If regionally important freshwater wetlands are going to be identified and protected, more fundamental research is needed (Sutter and Kral 1994, Kirkman et al. 1999). Our goal was to establish water quality and macroinvertebrate assemblages in wetlands in southwest Georgia with the hope that these reference conditions may provide a basis for judging human impacts and the quality of restoration efforts (Brinson and Rheinhardt 1996). Previous studies in streams have used invertebrates in biomonitoring to contrast disturbed and reference sites, but few bioassessments have occurred in wetland habitats. Our objectives were to evalute some potential indicators (i.e., metrics) to assess disturbed marsh wetlands (e.g., Barbour et al. 1996).

STUDY SITE

The study occurred in southwest Georgia on the Ichauway Ecological Reserve, Baker County. We identified five categories of wetlands based on their soil characteristics and vegetation: grass-sedge marshes, cypress savannas, cypress-gum swamps, disturbed marshes, and riparian sloughs (Goebel et al. 1997, Kirkman et al. 2000). The first four are types of depressional limesink wetlands and the last type occurs along river corridors (Allard 1990 as reported in Sutter and Kral 1994). Typically, these wetlands fill during late February and dry during early July, although duration of inundation is dependent on annual variation in rainfall as well as the basin morphology of individual wetlands.

METHODS

Wetlands were sampled for water quality in November 1998, February, April, August 1999, and February and September 2000. We attempted to sample three of each wetland type on every date, however, this was not always possible due to drought conditions. Temperature and dissolved oxygen

concentrations were measured in the field with a dissolved oxygen meter (YSI Model 50B). Water depth was recorded bi-weekly, using stationary staff gauges. On each sampling date, three water samples from each wetland were collected to determine alkalinity & pH (Mettler DL12 tritrator) and apparent color (HACH, DR/2000 Spectrophotometer). Water samples were then filtered and dissolved carbon levels were determined with a Shimadzu TOC-5050 analyzer. NH_4-N, NO_3-N, and PO_4-P were determined with a Lachat Quikchem 8000.

Macroinvertebrates were collected from 10 wetlands in April and 15 wetlands in August 1999 on the same date when water quality measurements were taken. Macroinvertebrates were sampled with a D-frame net (30.5-cm width, 500-µm mesh) by repeatedly sweeping the net five times over the same 1-m span. Samples were collected at three locations and preserved with 70% EtOH. Invertebrates were hand-sorted and identified (Pennak 1989, Epler 1996, Merritt and Cummins 1996).

Principle components analysis (PCA) was used to compare water quality among wetland types. Nonmetric multidimensional scaling (NMS) ordination was used to contrast macroinvertebrate assemblages among wetland types (McCune and Mefford 1997). Abundances were log transformed and multivariate analysis was completed using common taxa (n = 51), which we defined as taxa that occurred in >14% of all the samples.

To contrast reference and disturbed marshes, macroinvertebrates were identified from November 1998 and February, April, and August 1999 (n = 17). Metrics in Table 1 were based on Barbour et al. (1996), Davis (2000), and some that we derived. Sensitivity of metrics were evaluated using box-and-whisker plots, which were rated depending on the degree of interquartile (IQ) overlap of the plots: 3 = highly sensitive, no IQ overlap, 2 = some IQ overlap but no overlap of medians, 1 = moderate overlap of IQ, but at least 1 median is outside the IQ range overlap, and 0 = not sensitive, IQ overlap considerable (Barbour et al. 1996). In reference or disturbed wetlands if the median was below 6 taxa for richness metrics or the median was below 5% for percentage metrics, then the metric was rejected due to low values (Table 1).

Table 1. Metrics and their sensitivity score. Candidate metrics are in bold. 'Low values' indicate densities were too low to validate metric.

Category	Metric	Sensitivity score
Richness	**No. of taxa**	1
	No. of EPT taxa	Low values
	No. of Coleoptera taxa	1
	No. Crustacea taxa	0
Composition	% Oligochaeta	Low values
	% Odonata	Low values
	% Ephemeroptera	Low values
	% EPT	Low values
	% Coleoptera	0
	% Diptera	0
	% Chironomidae	0
	% Tanytarsini to chironomids	0
	% Gastropoda	Low values
	% Amphipoda	Low values
	% Isopoda	3
	% Crustacea	0
	% Hemipterans	0
	% Culicidae	0
	% Hirudinea	Low values
Trophic	% predators	0
	% gatherers	0
	% filterers	0
	% shredders	Low values
	% scavengers	3
	% piercers	Low values
	% scrapers	Low values
	No. piercers & scrapers	Low values
	Density	0
Habit	% burrowers	0
	% climbers & clingers	0
	% open respiratory	0

CONCLUSIONS

Multivariate analysis indicated that sloughs had the highest levels of inorganic carbon, nearly 10-fold higher than the depressional wetlands, and relatively high pH levels (Figure 1). Sloughs are inundated when the river is at high flow and as a result of the river's extensive riparian corridor there are large mineral and nutrient inputs. For depressional wetlands the major inundation source is precipitation so inputs are atmospheric or limited to runoff from the immediate surrounding uplands. Disturbed marshes had approximately five-fold greater PO_4-P concentrations (X = 5.5 ppb) compared to the other depressional wetlands. Disturbed marshes most likely derive nutrient inputs from soil and fertilizer runoff from nearby agricultural fields. The three depressional wetland types had a temporal shift in water quality,

with higher NH_4 and organic carbon levels, and greater staining of waters occurring late in the hydroperiod.

We identified 95 different taxa. The most common taxa were copepods, isopods, amphipods, and midge larvae (Battle and Golladay, in press). Sloughs and swamps had relatively low diversity and density (Figure 2). Large detritus inputs in these habitats result in low DO levels late in the hydroperiod that create stressful conditions for many invertebrates. Disturbed and reference marshes had similar densities, although reference sites had slightly higher taxa numbers. Belostomatidae (Hemiptera) and *Tropisternus* (Hydrophilid beetle) characterized both wetland types. Of the initial 31 metrics 4 were potentially sensitive indicators in distinguishing reference marshes from disturbed marshes (Table 1).

DISCUSSION

There were some distinct differences in water quality and macroinvertebrate communities among the wetland types. Water quality was most different between riverine and depressional wetlands. However differences in water chemistry among depressional wetlands was best detected by sampling in the mid or late hydroperiod. Macroinvertebrate assemblages appear to be primarily influenced by vegetation.

In general, oligochaetes, snails, and leeches were more prevalent in the disturbed sites than reference wetlands, although their numbers were highly variable. Metrics involving these taxa might become more reliable if we can determine the appropriate time to sample. The high variability may represent a seasonal condition where some taxa are more prevalent at different times of the year. We acknowledge that our study is preliminary and that to determine the opportune time to sample and to verify our results a larger sample size is required. Nonetheless, we did find two reliable metrics: % isopods and % scavengers. Both were higher in the reference sites than the disturbed marshes.

Invertebrates in depressional wetlands are quite capable of dealing with certain stresses (i.e., low DO, high temperature, and fluctuating hydrology). These stresses, which are a natural characteristic of wetlands, are often associated with degraded conditions in streams. Biomonitoring assumes that some taxa will be related with a negative impact, that is, they will have a positive or negative reaction to pollution. However, because wetlands have natural 'disturbances' it may make it more difficult to develop metrics since invertebrates are able to endure certain demands related

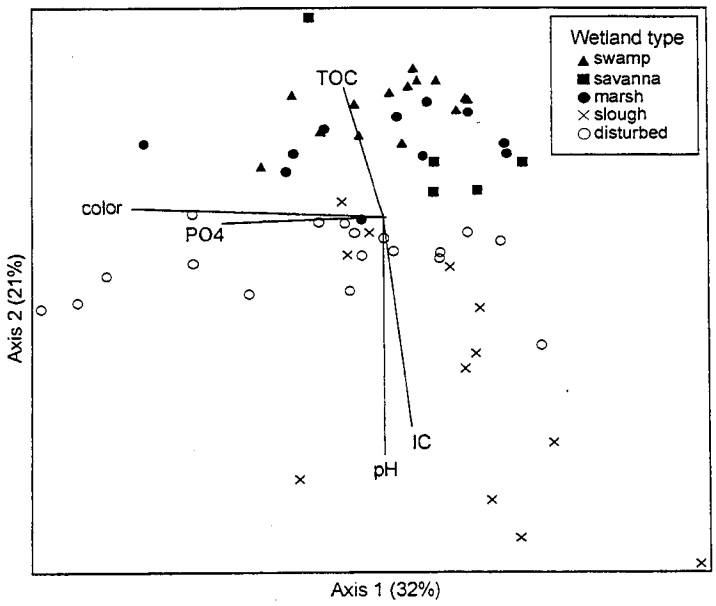

Figure 1. PCA of water quality data in 5 wetland types. TOC = organic carbon, IC = inorganic carbon, color = apparent color, PO4 = soluble reactive phosphorus.

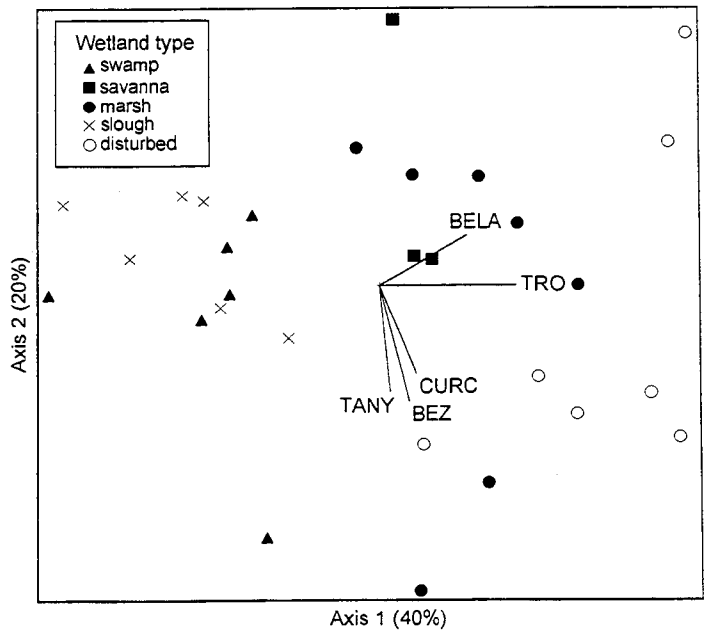

Figure 2. NMS of macroinvertebrates in 5 wetland types. BELA = Belostomatidae, TRO = *Tropisternus*, CURC = Curculionidae, BEZ = *Bezzia*, TANY = Tanytarsini.

to the habitat (Batzer and Wissinger 1996). In addition, our study occurred during a drought in Georgia and a previous study has shown that dry conditions can interfere with bioassessment efforts in Coastal Plain streams (Davis 2000). In Minnesota wetlands invertebrates were not a suitable indicator for disturbance, instead metrics that involved wading birds were more capable of indicating disturbance (Galatowitsch et al. 1999). If further studies reveal that invertebrates fail to denote stress in disturbed marshes they may not be suitable for biomonitoring in Georgia wetlands.

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